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ABSTRACT

The Specialized Teacher Project is a program designed to study the effect on pupil achievement in mathematics of a trade-off teaching assignment of mathematics classes combined with an appropriate inservice training program. In the trade-off arrangement, a teacher with particular interest in mathematics is paired with a teacher whose primary interest is in another area. The specific purpose of this study was to measure the achievement of second and fifth grade students who were taught by teachers who: (1) had inservice and traded-off establishing a home and a visited class; (2) had no inservice and traded-off; (3) had inservice but did not trade-off; (4) had no inservice and did not trade-off. Conclusions drawn from the results of the research include: (1) in grade 2, the inservice training program had a very strong effect on mathematics achievement whether or not the teacher traded-off; (2) in grade 2, the inservice training program was particularly effective in classes from disadvantaged areas; (3) in both grades, the trade-off arrangement did not have a large effect on mathematics achievement of either the home class or the visited class; (4) the inservice training program appears to have had a much more limited effect at grade 5 than at grade 2. (FL)

ED047950

RESEARCH REPORT

OF THE

SPECIALIZED TEACHER PROJECT

1968-1969

One of the
Mathematics Improvement Programs
Authorized by
California Education Code Section 5799

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California State Department of Education

February, 1970

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Services Performed by the
Department of Education, San Diego County
For and In Conjunction With the
California State Department of Education

Project Director: Jack Price, San Diego County Department of Education

Research Director: Robert Dilworth, California Institute of Technology

The Specialized Teacher Project Was Financed
From State Funds Appropriated for This Purpose

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INTRODUCTION

The Specialized Teacher Project of the Miller Mathematics Improvement Programs is provided for under sections 5799, 5799.1, 5799.2, 5799.4, 5799.11-5799.17, and 5799.46 of the Education Code. In effect these sections establish a program which provides for a specialized teacher in mathematics in various school districts of the State and an inservice activity to improve competency. The specialized teacher is a teacher who has an interest in mathematics yet no special training in the subject. The specialized teacher teaches at least two classes in mathematics, hers and that of a colleague, while the colleague teaches a trade-off class in place of the mathematics class.

There are two major features of the Specialized Teacher Project as outlined in the legislation and as developed during the year. These are the summer inservice regional workshops and the trade-off of mathematics classes. It was the task of the first year to determine what effects, if any, each of these two features had on the performance and attitudes of the second and fifth grade students concerned. Thus, a research study was designed which would measure the achievement of students who were taught by teachers who: (1) had inservice and traded-off establishing a home and a visited class; (2) had no inservice and traded-off; (3) had inservice but did not trade; (4) had no inservice and did not trade. There were sufficient classes from disadvantaged areas so that the effects of the socio-economic variable could also be evaluated in the study. The research design developed to determine these effects is described later in more detail.

FINDINGS AND CONCLUSIONS

The following conclusions are drawn from the results of the research described elsewhere in this study.

(1) In grade 2, the inservice training program had a very strong effect on mathematics achievement whether or not the teacher trades off. The classes of the teachers with inservice training averaged 10%-12% better scores in computation and 15%-20% better in comprehension. In grade 5, the inservice training program produced a measurable effect only in the area of the specific new material covered by the program.

(2) In grade 2, the inservice training program was particularly effective in classes from disadvantaged areas. These classes achieved 16%-19% better scores in computation compared to a 5%-6% better performance for the advantaged classes. In comprehension the disadvantaged classes had 18%-23% better scores while the advantaged classes achieved only 12%-15% better scores. Tables 1-4 show that the teacher who trades off is particularly effective with disadvantaged classes.

(3) In both grades 2 and 5, the trade-off arrangement did not have a large effect on the mathematics achievement of either the home class or the visited class. In grade 2, the evidence seems to indicate that the trade-off teacher does a somewhat better job with the home class than she would have done if the trade-off had not occurred. On the other hand, the visited class does not perform quite as well as either type of home class.

(4) Since the trade-off teacher is nearly as effective with the visited class as with the home class, and since inservice training for grade 2 appears to be very effective in improving mathematics achievement, the trade-off principle could well be used to double the effect of an inservice training program at this grade level.

(5) The inservice training program appears to have had a much more limited effect at grade 5 than at grade 2. While the grade 5 program clearly produced a higher level of achievement in the subject areas specifically covered in the inservice training, it had little effect outside of these areas. Part of the explanation for this phenomenon may lie in the difficulties associated with implementing the research design. For example, there were only three classes in the cell (I, T, Low S-E). It so happened that the teachers of these three classes were unusually

well qualified mathematics teachers. Table 7 (page 9) shows that the performance of these classes was quite inconsistent with the performance of the classes in the other cells. There are several other possible explanations. It may be that the instructors for the grade 2 program were simply much more successful than their counterparts for grade 5. Perhaps fifth grade teachers are more sophisticated and thus less likely to be influenced by inservice training. It is also possible that the emphasis of the inservice program for grade 5 was so strongly directed toward the presentation of the new material that broader objectives of mathematics instruction were neglected. At any rate, it is important to determine if this is a peculiarity of this particular experiment or if a general principle is involved. In the 1969-70 Specialized Teacher Project many more classes are participating and a variety of inservice training programs are being introduced. Thus the data from the second year of the program should provide information which will settle some of these conjectures. On the other hand, it is certain that other questions concerning the effectiveness of inservice programs will be raised which can only be answered through further modifications of the experimental programs.

Additional recommendations dealing with financial considerations will be found on page 15.

THE RESEARCH DESIGN

As outlined in the introduction, the Specialized Teacher Project is an experimental program set up to study the effect on pupil achievement in mathematics of a trade-off teaching assignment of mathematics classes combined with an appropriate inservice training program. In the trade-off arrangement, a teacher with particular interest in mathematics is paired with a teacher whose principal interest lies in another area. The first teacher teaches mathematics to both classes while the second teacher substitutes for the first in a non-mathematics class. Since the effects of an inservice training program are also being studied, the pairs of teachers are distributed among four cells:

T, I	$\overline{T}$, I
T, $\overline{I}$	$\overline{T}$, $\overline{I}$

where T, $\overline{T}$ denote trade-off and no-trade-off respectively, while I, $\overline{I}$ denote inservice and no inservice respectively. In order to minimize the possible effects of extraneous factors, every effort was made to insure that the teacher pairs were distributed among the cells in such a way that the cell-groups are similar as regards teacher experience, demographic character of the class, etc.

Since there are four categories of teacher-pairs, there are eight types of classes involved. These may be represented as follows:

T_1, I	T_2, I	$\overline{T}$, I	P, I
T_1, $\overline{I}$	T_2, $\overline{I}$	$\overline{T}$, $\overline{I}$	P, $\overline{I}$

where T_1 represents the home class of a trade-off teacher, T_2 represents the other class taught by a trade-off teacher, $\overline{T}$ represents the class of a non-trade-off teacher and P represents the class of a teacher paired with a non-trade-off teacher. In addition, there are classes from disadvantaged areas as well as from advantaged areas in each of the cells. Hence the basic design is a three-factor design with two levels for the inservice training variable, four levels for the trade-off variable and two levels for the socio-economic variable.

In 1968-69, the program was carried out at two grade levels--grades 2 and 5. The following tables give the number of classes in each cell for the two grade levels.

Grade 2

	T_1	T_2	$\bar{T}$	P
I	27	27	23	
$\bar{I}$	22	22	12	35

Grade 5

	T_1	T_2	$\bar{T}$	P
I	18	18	26	
$\bar{I}$	12	12	16	38

No inservice training was given to paired teachers in this first year of the program. The cell (P, I) is thus empty for both grade levels. Accordingly, only three levels of the teacher variable are used in the three-factor analysis.

Testing and Evaluation

The experimental program is designed to determine the effect of two teaching programs on mathematics achievement over the period of a school year. Hence the level of mathematics achievement must be measured at the beginning of the school year as well as at the end. In grade 2, a basic test of mathematical comprehension and a basic test of mathematical computation were administered in the fall. Each of these tests was modified by removing some of the elementary questions and substituting more advanced questions to provide basic tests of mathematical comprehension and computation for the end-of-year testing program. In grade 5, selected scales from the National Longitudinal Study of Mathematics Achievement (NLSMA) series of tests were used for both the fall and end-of-year achievement tests. These tests covered understanding as well as computational ability in the areas of whole number operations, operations with fractions, and informal geometric ideas. A special achievement test covering the areas of graphs, functions, and probability was administered in the spring. These were the areas which were emphasized in the inservice training and in the instructional program for the fifth grade. In grade 5, a selected set of attitude scales was also administered in both the fall and spring testing programs. Finally, as a general control variable, a standard reading test was given in both grades 2 and 5.

The basic data analysis consists of a covariance analysis for each of the spring scores using the fall scale scores as covariates. By this means, those factor effects which cannot be accounted for on the basis of the fall scores are measured for each of the spring scores. Since some scales are common to both the fall and spring testing programs, the factor-effects can also be studied in terms of the gain-scores. An analysis of variance on the gain-scores provides this factor information.

Summary of Statistical Results

Grade 2

It was noted above that some of the questions on the basic comprehension test administered in the spring were also present in the corresponding fall test. These questions form a natural subscale of elementary comprehension questions. The remaining questions on the spring comprehension test then constitute a subscale of more advanced comprehension questions. These two comprehension subscales are treated separately in the statistical analysis. In a similar manner the spring computation test is divided into elementary and more advanced subscales.

The three-factor covariance analysis on the spring scores with the fall scores as covariates shows a very strong effect from the inservice training on mathematical achievement. The F-ratios for the two comprehension scales are 27.1 and 23.0 and for the two computation scales are 21.2 and 21.9. For factors with two levels, F-ratios above 4.0 indicate a factor effect which cannot be accounted for by the underlying variability of the class scores. The F-ratios for the inservice training--socio-economic variable interaction are above the critical value for both computation scores. In each case the students from the disadvantaged areas profited more from the teachers inservice training. The F-ratios for the socio-economic factor are above the critical value for both the advanced comprehension and advanced computation scales. The values are 9.1 and 4.1 respectively. On each of these scales the scores for the classes from the disadvantaged areas were significantly lower than the scores for classes from advantaged areas even after adjustment on the basis of the fall scores.

None of the F-ratios for the teacher factor were above the critical value. Furthermore, there were no significant effects at all on the reading score.

The following tables give the adjusted mean scores for each of the comprehension and computation scales and the reading scale.

Table 1
ELEMENTARY COMPREHENSION

	T_1		T_2		$\overline{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.237	.244	.238	.233	.226	.249
$\overline{I}$	.195	.223	.180	.205	.198	.209

Table 2
ADVANCED COMPREHENSION

	T_1		T_2		$\overline{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.777	.807	.765	.815	.761	.838
$\overline{I}$	.644	.771	.632	.717	.681	.720

Table 3
ELEMENTARY COMPUTATION

	T_1		T_2		$\overline{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.765	.784	.819	.748	.746	.790
$\overline{I}$	.669	.755	.611	.698	.686	.736

Table 4
ADVANCED COMPUTATION

	T_1		T_2		$\overline{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.921	.946	.980	.896	.897	.949
$\overline{I}$	.790	.905	.736	.853	.807	.885

Table 5
READING

	T_1		T_2		$\overline{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.264	.281	.263	.264	.267	.270
$\overline{I}$	.251	.278	.266	.256	.251	.282

A separate one-factor covariance analysis was carried out on the entire data grouped with respect to the teacher variable. Thus there are four levels for this variable: T_1, T_2, $\overline{T}$ and P.

None of the F-ratios exceed the critical value. However the following table shows that the order of performance for the four groups is consistent over the four achievement scales.

Table 6
PERFORMANCE ON FOUR ACHIEVEMENT SCALES

	T_1	T_2	$\overline{T}$	P
Elementary Compreh.	.228	.223	.223	.208
Advanced Compreh.	.760	.758	.760	.702
Elementary Comput.	.754	.738	.749	.720
Advanced Comput.	.902	.892	.897	.867
Reading	.273	.263	.271	.274

Grade 5

One reading scale, six attitude scales and twelve mathematical achievement scales were administered to the fifth grade classes in the fall. In the spring, one reading scale, five attitude scales, and eleven achievement scales were administered. The three-factor covariance analysis produced F-ratios above the critical value for only one of the spring achievement scores--the scale covering graphs, functions, and probability. The material on graphs, functions, and probability was new to the experimental classes and was specifically covered in the inservice training program. The F-ratio associated with the inservice training factor was 9.3 which is well above the critical value of 4.0. The

F-ratio for the teacher variable was 3.3 which is slightly above the critical value of 3.1. The interaction of the teacher variable with both the inservice variable and the socio-economic variable had F-ratios slightly above the critical level. The following table gives the adjusted mean scores for this scale.

Table 7
GRAPHS, FUNCTIONS, AND PROBABILITY

	T_1		T_2		$\bar{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.596	.664	.651	.644	.605	.672
$\bar{I}$	.698	.607	.535	.575	.396	.598

One of the attitude scales, the Actual Arithmetical Self-Concept scale, also produced scores with significant F-ratios. The F-ratio associated with the inservice training factor was 5.10. The interaction between the inservice training and the socio-economic variable gave an F-ratio of 4.30 which is slightly above the critical value. The following table gives the adjusted mean scores for this scale.

Table 8
ACTUAL ARITHMETICAL SELF-CONCEPT

	T_1		T_2		$\bar{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.339	.372	.355	.358	.336	.362
$\bar{I}$	.351	.368	.370	.360	.376	.367

The results from the analysis of variance on the gain scores were essentially parallel to the covariance results but with somewhat lower reliabilities.

Complete statistical tables can be found in Appendix A.

THE INSERVICE PROGRAM

The major objectives of the inservice workshops were:

- to provide an open atmosphere in which teachers could learn to use more effectively the mathematics materials presently in the classroom.

- to explore with teachers the implications of the 1967-68 Strands Report of the Statewide Mathematics Advisory Committee.

- to teach the teachers more mathematics than they had classroom need for in a setting that applied it directly to the teaching situation.

- to bring to their attention the theories of Piaget, the Madison Project, and the Nuffield Program which put emphasis on laboratory approaches, intuition, and child development.

- to utilize a teaching approach that would cause teachers to enjoy mathematics and encourage them to develop further on their own - essentially what they in turn should do with their own students.

- to develop better teachers who could develop better students.

Staff of the Workshops

Because of the emphasis on improving classroom performance of teachers and because of previous success with Madison Project workshops, experienced teachers who had had previous inservice training responsibilities were selected to teach in the workshops. As was discovered later, this feature of the workshop was greatly appreciated. Participants were able to develop rapport with their instructors quite easily and the workshop experience did not turn out to be just another college class. (For documentation of this see the discussion of the teacher questionnaire, page 12.) The instructors selected were:

Mrs. Joan Akers, primary teacher, Santee School District
Mrs. Mary Dahle, primary teacher, Los Angeles City Schools
Mr. George Vojtko, district resource teacher, San Diego City Schools
Mr. Samuel Lipman, intermediate teacher, Cajon Valley Union School District

Mr. John Gessel, Curriculum Coordinator, San Diego County Department of Education, had general overall responsibility for the program of the workshops. His previous experience with similar programs for the National Science Foundation and with Robert Davis, Director of the Madison Project, prepared him extremely well for the task. He is now the director of Phase II of the Specialized Teacher Project.

Selection of the Participants

General guidelines for the Specialized Teacher Project were sent from the State Department of Education in March, 1968, to all school districts in the State. Districts were invited to submit applications for pairs of teachers for the project. From these applicants, random, arbitrary assignments were made to inservice, trade-off, and combinations of the two with regard to implementing the research design and to insuring wide geographical representation. Representatives from 48 school districts agreed to participate in the research project. Of this group, 130 were selected for inservice workshops at three locations in the State--San Diego, Fullerton, and Sacramento. The list of school districts and participants with their role in the research will be found in Appendix B.

Workshop Schedule and Activities

In order that the three workshops be as much alike as possible, careful planning by the staff was necessary. This came through three days of planning prior to the first workshop. Lesson plans for the two-week workshops were based on the objectives of the workshop tempered by the replies from a participant questionnaire: "What topics in your text are difficult to teach?" Analysis and evaluation of the materials and the concepts led to careful structuring of the workshop day, yet allowed a great deal of flexibility within the classrooms. Separate classes geared to second or fifth grade were set up. The daily time schedule for the classes was developed as follows:

8:30 - 9:30	Instruction
9:30 - 9:45	Break
9:45 - 10:45	Demonstration classes with children
10:45 - 11:00	Discussion of demonstration
11:00 - 11:30	Instruction
11:30 - 12:30	Lunch
12:30 - 1:30	Mathematics Laboratory
1:30 - 2:30	Instruction

A more detailed outline of the two-week schedule is found in Appendix C. That outline is a result of a daily reporting system that was in effect during the workshops. This reporting system gave immediate feedback with respect to implementation of the original lesson plans, served as an evaluation tool, and produced a record of the activities.

The mathematics laboratory was used in various ways: participants alone, children with a few participants, by participants in their off hours, or in many combinations of the children, staff, and participants. Appendix D gives a complete listing of the materials found in the mathematics laboratory as well as those materials given to each participant for use in his own school during the year.

Follow-up Activities

The follow-up sessions were held for the workshop participants, the first one in October and the second in March. The main objectives of the first session were to answer questions of the participants and to reinforce the concepts taught during the summer. The exchange of ideas that occurred during the question period was beneficial. As in the workshops themselves, problem area topics had been solicited in advance. The major objectives of the second session were to communicate plans for the 1969 version of the Specialized Teacher Project, to inform the teachers of some difficulties in the testing program, to answer further questions (again solicited in advance), and to develop some new enriching workshop lessons. According to the questionnaire administered (page 14), the follow-up sessions were of value to the participants.

Teacher Attitude Questionnaire

Near the end of the first year of the project, teachers were sent a questionnaire dealing with attitudes toward mathematics in general, mathematics teaching, and the inservice program in particular. Of the 130 participants, 113 returned the questionnaire. This 87% return is practically unheard of in research work and is a fair indication of the interest of the teachers in the program. Even though the entire questionnaire with percentage responses follows, some discussion should be made about the more interesting responses.

Sixty-five percent of the respondents felt that the inservice program was the best that they had ever had. Prior to the workshop only 20% of the teachers ranked mathematics as the favorite subject while 33% ranked it average or less. At the same time only 22% ranked mathematics as the favorite subject to teach and 40% ranked it average or below. Following the year in the project, 100% of the teachers liked mathematics better than average (57% favorite) and 98% ranked it above average in teaching preference. In addition, 94% of the

teachers said they would recommend the workshop to colleagues and 97% said they had positive feelings toward the workshops.

Each of the respondents made a statement about the program. The responses can be categorized into three major areas: improved student attitudes, greater knowledge of concepts to be taught, and improvement in methods of teaching.

SPECIALIZED TEACHER PROJECT

WORKSHOP PARTICIPANT QUESTIONNAIRE

Percentages indicated -- 113 responses from 130 participants

A. Where did you attend the summer workshop?
1. San Diego 29 2. Fullerton 34 3. Sacramento 37

B. How did the workshop compare with other inservice courses you have had?
1. Best ever 65 2. Better than most 33 3. Average 2 4. Worse than most 0 5. Worst ever 0

C. How did you like mathematics before you started the workshop?
1. Better than other subjects 20 2. Quite a bit 47 3. Average 26 4. Little 5 5. Not at all 2

D. How do you like mathematics now?
1. Better than other subjects 57 2. Quite a bit 43 3. Average 0 4. Little 0 5. Not at all 0

E. How did you like teaching mathematics before the workshop?
1. Better than other subjects 22 2. Quite a bit 37 3. Average 27 4. Little 13 5. Not at all 0

F. How do you like teaching mathematics now?
1. Better than other subjects 58 2. Quite a bit 40 3. Average 3 4. Little 0 5. Not at all 0

What is your opinion of the following workshop activities?
(Use 1-excellent, 2-very good, 3-good, 4-fair, 5-poor)

G.	Laboratory work	1 - 43	2 - 35	3 - 16	4 - 4	5 - 2
H.	Demonstration classes	1 - 50	2 - 36	3 - 12	4 - 0	5 - 1
I.	Small group instruction	1 - 45	2 - 37	3 - 16	4 - 2	5 - 0
J.	Films	1 - 15	2 - 34	3 - 33	4 - 14	5 - 2
K.	Peer-group teaching or sharing	1 - 22	2 - 35	3 - 33	4 - 14	5 - 2

L. On which of the above topics (items G-K) should more time have been spent?
1. G 21 2. H 25 3. I 34 4. J 2 5. K 12 No response - 6

M. On which of the above topics (items G-K) should less time have been spent?
1. G 16 2. H 8 3. I 4 4. J 28 5. K 29 No response - 15

N. How valuable were the followup sessions?
1. Very valuable 16 2. Valuable 34 3. Some value 28 4. Little value 17 5. No value 0 No response - 5

O. Would you recommend that colleagues enroll in the program?
1. Emphatically yes 72 2. Yes 22 3. Probably 4 4. Only if changed 2 5. No 1

P. Taking everything into consideration (workshop, followup, teaching, testing, communication, etc.), what is your general feeling about the program?
1. Highly positive 70 2. Positive 27 3. Neutral 2 4. Negative 2 5. Highly negative 0

Q. After careful thought, what would you say was the most significant aspect of the workshop program?_____

_____

_____

FINANCIAL CONSIDERATIONS AND RECOMMENDATIONS

In order to insure participation by teachers in the project for the first year it was necessary to provide stipends for them. Since most National Science Foundation institutes had paid $75 per week for participants, it was generally agreed that the same amount should be given in the Specialized Teacher Project. It was also realized that teachers who are taught new materials should be assured of some of these materials in their classrooms during the school year. For that reason each teacher was provided approximately $70 worth of materials for the school year.

Because only three centers were used, it was necessary for some of the participants to live away from home for the two weeks. Even though college housing was made available, the living expenses still averaged more than $60 for each non-commuter.

Instructional costs were also high because it was necessary to provide travel and living expenses for the instructors in addition to their salaries for seven weeks (six weeks of workshops plus one week planning).

Due to the complexity of the research design and the information required the average cost per student exceeded $3 for research. On the other hand the administrative expenses were underestimated.

Through analysis of the expenditures (see page 17), the following observations and recommendations are made:

1. Participant support cost twice as much for non-commuters as for commuters: $328 to $165. Thus, costs could be reduced if all participants were commuters. This would involve more centers, however, and a larger teaching staff.

2. The increased costs due to the greater number of teaching centers could be reduced if instructors were from the local areas served. As more teachers are trained, more will become able to carry on the inservice work themselves. Thus, more instructors will become available. However, larger inroads could be made into the problem if supervisors and college instructors could be exposed to the kind of inservice training that the teachers received in their workshops. To this end, it is recommended that a section be inserted in the Education Code which would allow at least one section in a workshop

in 1970-71 to be devoted to mathematics supervisors and coordinators and state college personnel charged with the responsibility for preservice programs in elementary mathematics education.

Thus, the increased center support costs would be more than offset by the decreased instructional costs.

3. If stipends could be eliminated, more materials could be provided and still the final result would be savings. The local centers might again accomplish at least part of this. Teachers are more likely to participate without stipends if the centers are close to home.

GROSS BUDGET CATEGORIES

Specialized Teacher Project
Miller Mathematics Improvement Programs

1968-1969

A.	Research		$ 12,000
B.	Participant Support		
	57 non-commuters: stipends plus travel	$15,250	
	living expenses	3,500	
		18,750	
	73 commuters: stipends plus travel	12,100	
			30,850
C.	Instructional Costs		
	4 instructors: salary, living expenses, travel costs (7 weeks)	18,050	
	Materials for participants and labs	10,000	
	Center support services, bus transportation, equipment rental	4,000	
			32,050
D.	Follow-up Meetings including participant expenses, instructors' salaries, travel, and expenses		8,600
E.	Administration		
	Part-time director, secretarial services, office expenses, mailing, commodities, supplies, telephone, overhead		16,500
			$100,000

APPENDICES

APPENDIX A

TABLES OF ADJUSTED MEAN SCORES

The adjusted means over the classes of each cell for each of the spring scale scores are presented in the tables of this appendix. The raw spring scale scores are adjusted by regressing on the fall pre-test scale scores. The adjusted mean scores thus correct for differences between classes at the beginning of the school year and hence provide measures of achievement over the year which are appropriate for comparison purposes. In particular, significant differences in the adjusted mean scores cannot be interpreted in terms of differences existing between classes at the beginning of the program.

Code

I	-	Inservice
$\overline{I}$	-	No Inservice
S, S-E	-	Socio-Economic
T	-	Trade-off Teacher
$\overline{T}$	-	No Trade-off Teacher
T_1	-	Home Class
T_2	-	Visited Class

HBW Reading Score - Grade 2

	T_1		T_2		$\bar{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.264	.281	.263	.264	.267	.270
$\bar{I}$	.251	.278	.266	.256	.251	.282

F-ratios

I	0.61
T	0.51
S	3.45
IT	0.17
IS	0.75
TS	2.20
ITS	1.10

SRA Score - Grade 2

	T_1		T_2		$\bar{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.600	.557	.608	.544	.564	.578
$\bar{I}$	.450	.583	.432	.501	.435	.513

F-ratios

I	15.30
T	0.63
S	1.40
IT	0.40
IS	7.36
TS	0.32
ITS	0.63

Elementary Comprehension Score - Grade 2

	T_1		T_2		$\overline{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.237	.244	.238	.233	.226	.249
$\overline{I}$	.195	.223	.180	.205	.198	.209

F-ratios

I	27.08
T	0.74
S	3.62
IT	0.21
IS	0.82
TS	0.10
ITS	0.98

Advanced Comprehension Score - Grade 2

	T_1		T_2		$\overline{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.777	.807	.765	.815	.761	.838
$\overline{I}$	.644	.771	.632	.717	.681	.720

F-ratios

I	23.01
T	0.26
S	9.05
IT	0.17
IS	0.57
TS	0.10
ITS	1.16

Elementary Computation Score - Grade 2

	T_1		T_2		$\bar{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.765	.784	.819	.748	.746	.790
$\bar{I}$	.669	.755	.611	.698	.686	.736

F-ratios

I	21.22
T	0.58
S	2.75
IT	1.44
IS	4.73
TS	0.53
ITS	1.42

Advanced Computation Score - Grade 2

	T_1		T_2		$\bar{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.921	.946	.980	.896	.897	.949
$\bar{I}$	.790	.905	.736	.853	.807	.885

F-ratios

I	21.90
T	0.41
S	4.12
IT	0.80
IS	6.05
TS	0.50
ITS	1.29

HBW Reading - Grade 5

	T_1		T_2		$\overline{T}$	
	Low S-E	High S-E	Los S-E	High S-E	Low S-E	High S-E
I	.348	.362	.341	.348	.332	.356
$\overline{I}$	.361	.359	.335	.355	.344	.351

F-ratios

I	0.25
T	1.66
S	2.59
IT	0.04
IS	0.28
TS	0.20
ITS	0.67

Actual Arithmetical Self-concept - Grade 5

	T_1		T_2		$\overline{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.339	.372	.355	.358	.336	.362
$\overline{I}$	.351	.368	.370	.360	.376	.367

F-ratios

I	5.10
T	0.16
S	3.23
IT	1.14
IS	4.30
TS	2.51
ITS	0.37

Ideal Arithmetical Self-concept - Grade 5

	T_1		T_2		$\overline{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.312	.291	.311	.299	.316	.311
$\overline{I}$	.293	.301	.311	.295	.292	.300

F-ratios

I	1.79
T	0.30
S	0.82
IT	0.63
IS	1.05
TS	0.52
ITS	0.63

Arithmetic, Easy vs. Hard - Grade 5

	T_1		T_2		$\overline{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.284	.301	.302	.291	.284	.289
$\overline{I}$	.290	.294	.312	.298	.279	.299

F-ratios

I	0.46
T	2.21
S	0.44
IT	0.29
IS	0.00
TS	2.57
ITS	0.58

Debilitating Anxiety - Grade 5

	T_1		T_2		$\bar{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.256	.237	.246	.229	.250	.250
$\bar{I}$	.234	.236	.212	.241	.251	.228

F-ratios

I	3.36
T	1.48
S	0.49
IT	0.00
IS	1.54
TS	0.89
ITS	2.75

Decimal Notation Score - Grade 5

	T_1		T_2		$\bar{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.327	.320	.334	.303	.316	.310
$\bar{I}$	.382	.299	.285	.300	.344	.310

F-ratios

I	0.02
T	1.14
S	2.18
IT	1.00
IS	0.50
TS	0.56
ITS	1.63

Translation Score - Grade 5

	T_1		T_2		$\bar{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.401	.423	.420	.436	.391	.417
$\bar{I}$	.457	.422	.411	.416	.479	.419

F-ratios

I	1.87
T	0.07
S	0.07
IT	1.54
IS	3.34
TS	0.32
ITS	0.63

Working With Numbers Score - Grade 5

	T_1		T_2		$\bar{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.458	.477	.504	.504	.474	.465
$\bar{I}$	.592	.468	.446	.456	.395	.459

F-ratios

I	0.31
T	2.05
S	0.08
IT	3.30
IS	0.26
TS	1.38
ITS	2.41

Geometry, Informal Ideas Score - Grade 5

	T_1		T_2		$\overline{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.185	.323	.313	.263	.239	.325
$\overline{I}$	.335	.247	.211	.260	.171	.252

F-ratios

I	1.77
T	0.47
S	2.72
IT	2.30
IS	1.05
TS	1.33
ITS	4.87

Whole Numbers, Subtraction Score - Grade 5

	T_1		T_2		$\overline{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.208	.254	.250	.236	.209	.259
$\overline{I}$	.248	.253	.241	.246	.266	.238

F-ratios

I	1.09
T	0.02
S	0.76
IT	0.28
IS	1.93
TS	0.52
ITS	1.42

Whole Numbers, Division Score - Grade 5

	T_1		T_2		$\overline{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.088	.102	.130	.113	.072	.112
$\overline{I}$	.108	.121	.068	.110	.118	.114

F-ratios	
I	0.16
T	0.00
S	2.30
IT	3.71
IS	0.05
TS	0.03
ITS	2.53

Fractions, Subtraction Score - Grade 5

	T_1		T_2		$\overline{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.085	.096	.083	.096	.063	.086
$\overline{I}$	.078	.084	.062	.091	.084	.103

F-ratios	
I	0.02
T	0.03
S	3.93
IT	1.37
IS	0.03
TS	0.25
ITS	0.17

Whole Numbers, Computation Score - Grade 5

	T_1		T_2		$\overline{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.765	.750	.835	.750	.658	.789
$\overline{I}$	.859	.792	.754	.772	.838	.772

F-ratios	
I	2.25
T	0.32
S	0.21
IT	1.75
IS	0.81
TS	0.75
ITS	2.64

Fractions, Computation Score - Grade 5

	T_1		T_2		$\overline{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.233	.211	.246	.228	.192	.226
$\overline{I}$	.275	.207	.192	.228	.244	.222

F-ratios	
I	0.17
T	0.21
S	0.50
IT	1.57
IS	0.38
TS	1.57
ITS	1.69

Graphs, Probability, and Functions Score - Grad 5

	T_1		T_2		$\bar{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.596	.664	.651	.644	.605	.672
$\bar{I}$	.698	.607	.535	.575	.396	.598

F-ratios	
I	9.32
T	3.27
S	2.86
IT	4.25
IS	0.03
TS	3.66
ITS	3.41

Whole Numbers, Division Score - Grade 5

	T_1		T_2		$\bar{T}$	
	Low S-E	High S-E	Low S-E	High S-E	Low S-E	High S-E
I	.205	.173	.239	.188	.164	.197
$\bar{I}$	.236	.202	.168	.205	.219	.204

F-ratios	
I	0.91
T	0.13
S	0.56
IT	2.54
IS	0.29
TS	0.91
ITS	2.76

APPENDIX B

LIST OF PARTICIPANTS BY DISTRICT

SPECIALIZED TEACHER PROJECT
MILLER MATHEMATICS IMPROVEMENT PROGRAMS

Teacher Participants by District
1968-69

Key: T = Trade-off I = Inservice
NT - No Trade-off NI = No Inservice

Bellflower

NT-I	Fred Schumock
NT-NI	Alma Beck
T-I	Hazel Mestad
T-NI	Edith Campbell

Carlsbad

NT-I	Lillie Black
NT-NI	Eleanor Cook

Castro Valley

T-I	Dean Leuthauser
T-NI	Barbara Schultz

Chula Vista

T-I	Barbara Seiler
T-I	Diane Elliott
T-I	Eva Rice
NT-I	Dolores Lindon

Clovis

NT-NI	Dorothy Johnson
NT-I	Edith Schumucher

Compton

NT-I	Nettie Smith
NT-NI	Dorothy Harris

Duarte

T-NI	Dorothea Leonard
T-I	Beverly Gage
T-I	Warren Proud
T-NI	Mary Elliott

East Whittier

NT-NI	Phyllis McClintock
NT-I	Emma Smith
NT-NI	Ruth Lannom
NT-I	Marty Martin

El Monte

NT-NI	Curtis Herd
NT-I	Lawrence Olson

El Rancho

NT-NI	Jean Hilsinger
NT-I	Sharon Porner
NT-I	Evelyn Gilpin
NT-NI	Jo Haynes

Enterprise

NT-I	Viola Novak
T-NI	Herbert Greer
T-I	Robert Galewick

Escondido

T-NI	Frances Burns
T-I	Eileen Dennison

Fairfield

T-I	John Wright
T-NI	Forest Ferry

Fort Bragg

T-I	Marion Gjerde
T-NI	Bob Stephens

Fresno

T-I	Kay Swan
T-NI	Francelia Carpenter
T-I	Norma Dupzyk
T-NI	Edna Overall
NT-NI	Joyce Haney
T-I	Bonnie Reiss
T-NI	Dorothy Kooyumijian
NT-NI	Leona Cyr
NT-I	Carrol Fritz
T-NI	Evelyn Forbes
NT-NI	Nancy Schulmeister
NT-I	Nellie Mosley
NT-I	Rosalin Nalbandian
NT-NI	Emma Hoopengarner
T-I	Rosemary Corwin
T-NI	Valerie Badvelian
T-NI	Philys Bence
T-I	Florence Byrnes
T-NI	Adele Bartholomew
T-I	Agnes Mathiesen
NT-I	Maria Nunez
NT-NI	Mary Beth Baca
NT-NI	Robert McClung
NT-I	Jane Callahan
T-I	Jeannette Hubbart
T-NI	Charles Clark
NT-I	Beverly Hardison
NT-NI	Chuck Vanderford
NT-I	Miriam Allen
NT-NI	Diane Tukloff
NT-NI	Jewell Estill
NT-I	William Putler
NT-NI	William Whiteside
NT-I	Lydia Oja
T-NI	Stanley Ostrom
T-I	Marjorie Hinkly
T-I	Merrill Hardison
T-NI	Marian Smith

Fullerton

NT-NI	Hilda Chellis
NT-I	Margaret Wise
T-NI	Jo Kamm
T-I	Phyllis Huestis
NT-I	Virginia Sellers
NT-NI	Keith Coons
T-I	Judy Lewis
T-NI	June Gienapp
NT-NI	Wilma Bohannan

Glendora

NT-I	Joan Schoolmaster
NT-NI	Olive Mardok
T-NI	Eleanor Ouelett
T-I	Margaret Rector
NT-NI	William Heisel
NT-I	Russell Welte
T-I	Fonda Booth
T-NI	Richard Giles

Goleta

NT-NI	Linda Carey
NT-I	Doris Caswell

Jamestown

T-NI	Darryl Rosenheim
T-I	Phillip Hayes

Jurupa

T-NI	Faye Edmunds
T-I	Geneva Franklin
NT-I	Sally Yurkovich
NT-NI	Roberta Bass
NT-I	Helen Farmer
NT-NI	Valdrice Houg
T-NI	Winifred Freeman
T-I	Lila Culling
T-NI	Ollen Hardin
T-I	Hattie Bird
NT-I	Otila Moody
NT-NI	James Shearer
NT-NI	Sherry Meeks
NT-I	Thelma Center
T-I	Celia Blutman
T-NI	Clifford Sexton

La Mesa-Spring Valley

T-I	E. L. Crane
T-NI	Elizabeth Dennis
NT-NI	Josephine Stahnke
NT-I	Grace Lyons

Lemon Grove

T-NI	Loy Holmquist
T-I	Joan Wittrock

Lodi

NT-NI	Don Sommerfield
NT-I	June Fields

Lompoc

NT-I	Diana Noble
T-I	Don Banmann
T-NI	John Hartman

Long Beach

T-NI	Judith Kubik
NT-NI	Rosemarie Gordon
NT-I	Joyce Pendleton
NT-I	Bernice Corrigan
NT-NI	Thelma Hutton
T-I	Violet Moody
T-NI	Marjorie Walker
T-NI	Barbara Petersen
NT-I	Dorothy Anderson
NT-NI	Louis Rouse

Los Angeles

T-I	Bernice Roland
T-NI	Margery King
T-I	Gwen Freeman
T-NI	Earline Lyons
NT-I	Leigh Kawakami
NT-NI	Charlotte Lewis
T-I	Edythe Richardson
T-NI	Clare Vance
T-I	Caren Von Hagen
T-NI	Patricia Kawamoto
NT-NI	Eva Hathcock
NT-I	Deanna Vasquez
T-I	Marvice Thornton
T-NI	Patricia Turner
NT-NI	Adele Wilder
NT-I	Thelma Watkins
T-NI	Alberta Lee
T-I	Lorraine Bourgeois
NT-NI	Marilyn Nevards
NT-I	Ellen Morgan
NT-NI	Ruth Gimble
NT-I	Helen Thompson
T-NI	Ruth Dossey
T-I	Ellen Sutter

Los Nietos

T-NI	Joan Wilkes
T-I	Hazel Hodel

Marysville

T-I	Robert Misner
T-NI	Martha Shepherd

Menlo Park

NT-I	Agnes Abend
NT-NI	Glenda Murray

Monrovia

T-NI	Jeanne Bell
T-I	Joan Oeltman

Newark

T-I	Georgia Curtiss
T-NI	Laura Rankin

New Haven

NT-NI	Merle Santos
NT-I	Kelie Medeiros
NT-NI	Alba Lavino
NT-I	Lola Zielon

Norwalk-La Mirada

T-NI	Norinne Marcum
T-I	June Miyamoto
NT-I	Carol Stallman
NT-NI	Marie McCanlies
NT-I	Jack Hively
NT-NI	Ira Lynn
NT-NI	Janet Denkins
NT-I	JoAnn Kimura
T-I	Jeannine Goenne
T-NI	Grave Havick
NT-I	Mary McNeil
NT-NI	Barbara Kaminski

Oakland

T-NI	Helen Lee
T-I	Dorothy Cunliffe
NT-NI	Rosemary Holan
NT-I	Bonnie Harrion
T-I	Junko Kako
T-NI	Margaret Byrne
T-I	Mary Nelson
T-NI	Lasca Paulson
NT-I	Anastasia Zoslosky
NT-NI	Wanda Woods
NT-I	Margit Walden
NT-NI	Maryanne O'Beirne
NT-I	Robert Smith
NT-NI	William LaRue

Ocean View

T-I Cherub Tomei
T-NI Jeralyn Winn

Oxnard

NT-NI Adelaide Roethel
NT-I Rosemary Nevels

Plumas

T-NI Sarah Jacobson
T-I Karen White

Red Bluff

T-NI Edward Van Vleet
T-I Ernest Sanford

Redondo Beach

T-NI J. Ferguson
NT-I Grace Isenogle
NT-NI Lynne Marmor
T-I Beth Inghram
T-NI Charles Holly
T-I Sybil Conn

Richmond

NT-NI Gloria Fujimoto
NT-I Mary Hibdon
NT-NI Helen Hawkins
T-I Norma Brown
T-NI Anita Audibert
T-I Elsie Matsuo
T-NI Linda Webster

Sacramento

NT-I Catherine Sweeney
T-NI Eleanor Lane
T-I Irma Backer
T-NI Crystal Lillie
NT-NI Dorie McLoughlin
NT-I Dorothy Stadler
NT-I Jacqueline Gaston
NT-NI Joan Lewis
T-NI Elizabeth Freed
NT-NI Patricia Campbell
NT-NI Sylvia Dion
NT-I Elizabeth Stafford
T-NI Art Kempe
T-I Conrad Johnson
NT-I Donald Missig
NT-NI Dolores Holland
NT-NI Burton Smith
NT-I Albert Hunger

San Diego

NT-I Carolyn Call
NT-NI Betty Kvikstad
NT-I Lora Henzie
T-NI Jereth VanHooser
T-I Diane Sypher

San Francisco

T-I Marilyn Gagne
T-NI Nancy Sequeira
T-I Peter Youdall
T-NI Sam Louie
NT-NI John Moore
NT-I Virginia Helleskov

San Mateo

NT-NI Ruth Clark
NT-I Anita Heagarty
T-I Stanley Schwerin
T-NI Harold Schecket

Santee

T-I Elta Trousdale

Vallejo

T-NI Agnes Basham
T-I Margaret Enea
NT-NI Mildred Irwin
NT-I Mary Lou Nachbaur

Valley Oaks

T-NI Lowell Dickmeyer
T-I Lyle Bohanon

Ventura

T-I Delilah Pomatti
T-NI Ann Peters

6/21/68

APPENDIX C

TYPICAL TWO-WEEK WORKSHOP CLASS ACTIVITY SCHEDULE

Grade 2

Grade 5

TYPICAL CLASS ACTIVITY SCHEDULE FOR GRADE 2

July 8, 1968

Introduction and Forms

Attribute Blocks
- (a) Generating the Set
- (b) Guess My Rule
- (c) Intersections

Film: "How to Teach More Math"

Lab (1 hour) - Individual Activities

Introduction to Graphing
Class made group graph; then small groups collected data and made graphs

Tic Tac Toe (One Quadrant)

Pebbles in the Bag

Assignment: Read Pictorial Representations

July 9, 1968

Number Sentences
- (a) True, false, and open
- (b) Rule for substitution
- (c) Inequalities
- (d) Use of variables

Tic Tac Toe in Four Quadrants

Children Demonstration
- (a) Graphing - empirical
- (b) Making bean sticks

Discussion and Evaluation of Children's Demonstration with Participants

Pebbles in the Bag - Small Group Practice

Postman Stories

Lab Work (45 minutes)

July 9 cont'd.

Film: "Math's Alive"

Discussion
- (a) Relation of lab activities to regular program
- (b) Areas of second grade difficulty
  - (1) Missing addend
  - (2) Methods of drill on basic facts

Geoboards
Introduction and exploration work with area of shapes

Assignment: Geoboard. Read Inquiry in Math via Geoboard, Don Cohen.

July 10, 1968

Review of True, False, and Open Sentences

Guess My Rule

Linear Graphing
Generalize on zero intercept and slope pattern

Children Demonstration
- (a) Bean Sticks
  - Showing numbers using bean sticks
  - Renaming numbers
  - Introduction to addition of 2-place numbers
- (b) Guess My Rule
- (c) Tic Tac Toe (one quadrant)

Discussion and Evaluation of Children's Demonstration

Discussion of Guidelines of Specialized Teacher Program (MMIP) - Bess Frank

Discussion of Geoboard Homework Problems

Cuisenaire Rods
Introduction: Patterns, trains, naming rods

Assignment: Cuisenaire rods; Mathematical Awareness, Parts I, II; Strands Report, Part I.

July 11, 1968

Review of Linear Graphing

Quadratics - Discovered ways to find roots

Children Demonstration

(a) How many macaroni pieces in a jar?
(b) Tic Tac Toe - Participant-led game
(c) Attribute Blocks - Generating the set - 3 small groups led by participants
(d) Lab - Children working in small groups with participants on:
    (1) Mirror Cards
    (2) Balances
    (3) Dienes' Blocks
    (4) Triangular Dominoes
    (5) Bottles - Comparison of height and volume
    (6) Pattern Blocks
    (7) Attribute Blocks, People Pieces

Evaluation of Children Demonstration and Discussion of Homework Assignment

Film - "I Do, And I Understand"

Measurement - Small group problems in measuring requiring the use of objects from the environment as units

Cuisenaire Rods - Non-numeral addition and subtraction, meaning of equal sign, missing rod equations, commutativity

Assignment: Attribute Blocks and Manual

July 12, 1968

Measurement Activities (Small group):

(a) Concepts: Need for consistent unit of measurement.
    Any object has several aspects to be measured.
    Place of estimation in measurement.

Children:

(a) Cuisenaire Rods - 3 groups (taught by participants)
(b) Geoboards - 2 groups (taught by participants)
(c) Pebbles in the Bag - 2 groups (taught by participants)

Lab (45 minutes):

(a) Lucas materials

July 12 cont'd.

Linear Graphing:
- (a) Recognition of linear truth tables
- (b) Predict graph from truth table
- (c) Discover significance of first and second differences
- (d) Graphing of quadratics

Lattices - David Page

Assignment:
- (a) Beryl Cochran's Notes
- (b) Pupil Editions of Davis' Discovery

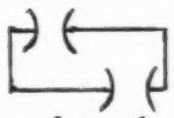
July 15, 1968

Math Workshop Activities:
- (a) Pencils and erasers sale problem

Books Passed Out - Organization and Activities Discussed

Silent Guess My Rule (Wirtz book)

Children:
- (a) Number sentences: true, false, and open
- (b) Rule for substitution
- (c) Tic Tac Toe in 2 quadrants
- (d) Lab:
  - (1) Estimation and calculating approximate amount of macaroni in jar
  - (2) Dienes' blocks
  - (3) Water and bottles
  - (4) Balances
  - (5) Games, puzzles, geometric shapes
  - (6) Calculators

Machine Arithmetic (Wirtz) 

- (a) Tied in with analysis of truth tables using first, second, and third differences

Film: "Conservation" - Piaget - Dr. Karplus
- (a) Discussion of implications for teaching

Coin Combinations Problems

July 16, 1968

Postman Stories
- (a) Review of addition and subtraction of signed numbers
- (b) Multiplication of signed numbers

Guess My Rule
- (a) Simple cubic and exponential functions

Graphing Worksheet
- (a) Review of linear and quadratic graphs, cubic graphs

Children Demonstration:
- (a) Calculating number of macaroni in jar after estimation
- (b) Bean Sticks:
  - (1) Trading 10 beans for a stick
  - (2) Addition and subtraction with regrouping
- (c) Clock arithmetic
- (d) Variation:
  - (1) Data gathering and distribution table of number of peas in pod
  - (2) Recognition of normal curve
  - (3) Identifying

Lab (1 hour)

Modular Arithmetic
- (a) Modulo 5
  - (1) Addition and multiplication tables, patterns in table, congruencies, other modular systems

Discussion of Morning's Graphing Worksheet

July 17, 1968

Geometry of a Flattened Box -- symmetries (milk cartons)

Children:
- (a) Kalah game (Small groups; taught by participants)
- (b) Maneuvers on Lattices (Small groups; taught by participants)
- (c) Lucas materials (Small groups; taught by participants)

Estimation and Measurement Tasks
- (a) Trundle wheel - linear
- (b) Area - using linoleum squares
- (c) Bottles - liquid measure - comparison
- (d) Scale - weight of peas and particles (5)
- (e) Linear - using Cuisenaire Rods
- (f) Cars and ramp - relation of height of ramp and distance traveled

July 17 cont'd.

Discussion and Evaluation of Demonstration

Lab--Usual Activities Plus:
- (a) Indirect measurement of height using hypsometer
- (b) Standardization of pace
- (c) Kalah game
- (d) Pick-Up-Twenty-One Game

Film: "Classification" - Piaget

Discussion
- (a) Setting up a math lab with just the available materials

July 18, 1968

Group of the Symmetries of an Equilateral Triangle
- (a) Developed and compared with Modulo 6

Topology Booklet

Children:
- (a) Million zeros - problem solving to verify numbers
- (b) Probability - introduction:
  - (1) "What can you say for sure?"
  - (2) Prediction and group verification using coins and spinners
  - (3) Linear graphing - introduction

More Probability with Adults

Identities

Counting Squares Function

Lunch

July 19, 1968

Matrices

Culminating Activities

TYPICAL CLASS ACTIVITY SCHEDULE FOR GRADE 5

July 8, 1968

Robert Wirtz Film No. 1 - "How to Teach More Math"

Number Patterns and Operations

Numer Line Activities

True, False, and Open Sentences

What's My Rule?

Introduction to Cuisenaire Rods (With Cards)
- (a) Patterns
- (b) Symmetry
- (c) Number sentences: true, false, open

Laboratory Activities

Distribution of Materials
- (a) Cuisenaire Rods
- (b) Strands, Part 1
- (c) Mathematical Awareness

Discussion and Critique

July 9, 1968

Patterns, Puzzles, What's My Rule?

Pebbles in the Bag

Demonstration with Pupils
- (a) Number Sentences: true, false, open
- (b) What's My Rule?

Guess My Rule

Attribute Blocks

Laboratory Experiences

Pictorial Graphing

July 9 cont'd.

Distribution of Materials
- (a) Attribute Blocks (with Book)
- (b) Pictorial Representations

Discussion and Critique

July 10, 1968

Patterns, Puzzles, What's My Rule?

Pet Shop Stories

Open Sentences of the Form $(\square \times \square) - (5 \times \square) + 6 = 0$

Demonstration with Pupils
- (a) Pebbles in the Bag
- (b) Plotting Points (4 quadrants)

Graphing Linear Equations

State Department Report--Bess Frank

Geoboard Activities

Lab Experiences

Film: "I Do, And I Understand"

Distribution of Materials
- (a) Inquiry via the Geoboard

Discussion and Critique

July 11, 1968

Plotting Points in Four Quadrants

Postman Stories for Addition and Subtraction

Pairing Off for Postman Stories

Demonstration:
- (a) True, false, and open
- (b) Guess My Rule
- (c) Multiple examples of rules

July 11 cont'd.

Introduction to the Balance

Lab Experiences

Guess My Rule - Differences

Distribution of Materials
(a) Balance with Book

Discussion and Critique

Staff Meeting

July 12, 1968

What's My Rule?

Writing Truth Tables

Linear Graphing in Four Quadrants

Postman Stories for Multiplication

Demonstration
(a) Geoboard with teacher and 3 pupils
(b) Balance with teacher and 3 pupils
(c) Tangrams with teacher and 4 pupils
(d) Attribute Blocks with teacher and 3 pupils

Game: Battleship, Cruisers, Carriers, and PT Boats

Number Line Transformations

Laboratory

Discussion and Planning Next Week's Program

Distribution of Materials
(a) Tangrams
(b) Linear Graphing Cards

Staff Meeting

July 15, 1968

Estimation and Measurement (Nonstandard and standard units):

(a) Classroom activities
(b) Out-of-doors activities
(c) Critique and discussion

Demonstration:

(a) Fractional numbers on the number line
(b) Graphing ordered pairs

Geoboard Board Activities (Small groups)

Laboratory Activities

Multiplication and Division of Signed Numbers

Distribution of Materials:

(a) Estimation and Measurement Cards

Discussion and Planning for Next Day

Staff Meeting

July 16, 1968

Introduction to Probability

Probability Experiments

Demonstration with Pupils:

(a) Making truth tables
(b) Graphing functions
(c) Discussion with teachers regarding the demonstration

Arrow Arithmetic

Finite System (Flips and rotations)

*	I	V	H	R
I	I	V	H	R
V	V	I	R	H
H	H	R	I	V
R	R	H	V	I

Properties

(a) Closure

(b) Commutative

(c) Associative

(d) Identity

July 16 cont'd.

Laboratory Activities

Film - "Math's Alive"

Planning Activities for the Following Day with Participants

Distribution of Materials:
(a) Probability - Student
(b) Discovery - Student

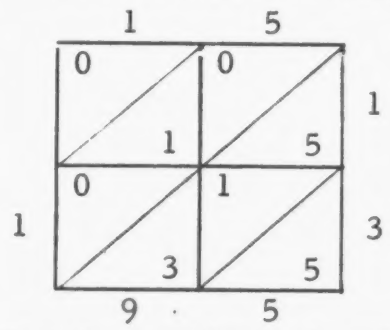
Staff Meeting

July 17, 1968

Modular Systems (Mod 12 and Mod 6)
(a) Properties of modular systems
(b) Mod system tables

Demonstration by Participant
(a) Addition postman stories
(b) Subtraction postman stories
(c) Truth tables

Inquiry lesson
(a) Lattice method of multiplication



(b) Egyptian method of multiplication

4 x 4	5 x 7	4 x 7
2 8	2 14	2 14
1 16	1 28	1 28
(16)	(35)	(28)

Base Five Numeration System

Probability (Pascal's triangle)

Planning Time by Participants for Next Day's Demonstration with Pupils (Estimation and measurement)

July 17 cont'd.

Distribution of Materials:

(a) Operations with a desk calculator
(b) GB1-1
(c) Coordinate geometry with geoboard, GB2-1
(d) GB3-1
(e) Coordinate geometry GB4-1
(f) Place-value - Dienes' blocks

July 18, 1968

Examination of Book D, Math Workshop for Children

(a) Sequences
(b) True or false statements
(c) Properties of operations (addition, subtraction, multiplication, division)
(d) Algorisms
(e) Fractional numbers, decimals
(f) Primes and factors
(g) Euler routes, number theory
(h) Functions

Problem Solving

Science and Math Applications

Demonstration with Pupils (Participants)

(a) Estimation
(b) Measurement

Evaluation of Demonstration

Examination of Book E, Math Workshop for Children

(a) Measurement (standard metric units)
(b) If-Then statements
(c) Decimals, fractions, prime factorization
(d) Geometry, functions

Writing a list of suggested pages from Books D and E that may be used with each Learning Stage of the Basic Text - Grade 5

Discussion of Teacher's "Expressed Needs" with Respect to the Basic Text

Distribution of Materials

(a) Strands Report, Part II
(b) Discovery in Mathematics
(c) Mathematical Awareness, Part II

July 19, 1968

Matrices

Discussion:

(a) Setting up a laboratory
(b) Teaching the four operations
(c) Use of the textbook (basic)
(d) "Expressed needs" of teachers

Problem Solving Activities

Inquiry Methods and Activities

Discovery Methods of Teaching

Evaluation of the Two-Week Workshop

Distribution of Materials:

(a) Experiments in Mathematics, Stages 1 and 2
(b) Experiences in Discovery, Levels C and D

APPENDIX D

MATERIALS USED AND/OR RETAINED BY PARTICIPANTS

Workshop Materials

Manipulative Mathematics Laboratory Materials

Motion Pictures

WORKSHOP MATERIALS

1. John Wiley and Sons, Inc.
   1530 South Redwood Road
   Salt Lake City, Utah 84104

   a. How to Build a Pond . . . . . $ 1.75
   b. I Do, And I Understand. 1.95
   c. Mathematics Begins 2.25
   d. Pictorial Representation 2.25
   e. Beginnings. 2.50
   f. Computation and Structure 2.50
   g. Shape and Size 2.50

2. Appleton, Century, and Crofts
   440 Parks Avenue
   South New York, New York 10016

   a. Guiding Discovery in Elementary Mathematics 7.50

3. Holt, Rinehart and Winston, Inc.
   383 Madison Avenue
   New York, New York 10017

   a. Teaching Aids for Elementary Mathematics 2.95
   b. Developing Number Experiences, Kit A 24.00

4. National Council of Teachers of Mathematics
   1201 16th Street
   Washington, D.C. 10036

   a. Enrichment Mathematics for the Grades. 1.50
   b. Topics in Mathematics (29th Yearbook of the Council) 4.00

5. Silver Burdett Company
   A Division of General Learning Corporation
   Morristown, New Jersey

   a. Experiences in Discovery - Level C 80
   b. Experiences in Discovery - Level D 80

6. Houghton Mifflin Company
   777 California Avenue
   Palo Alto, California

   a. Experiments in Mathematics - Stage 1 . . . . . 1.20
   b. Experiments in Mathematics - Stage 2 . . . . . 1.20
   c. Experiments in Mathematics - Stage 3 . . . . . 1.20

7. Addison-Wesley Publishing Company, Inc.
Reading, Massachusetts 01867

a.	Discovery in Mathematics - Student	$ 2.10
b.	Discovery in Mathematics - Teacher	6.00
c.	Explorations in Mathematics - Student	2.10
d.	Explorations in Mathematics - Teacher	6.00

8. The Madison Project
Webster College
8356 Big Bend Boulevard
St. Louis, Missouri 63119

a.	A Collection of Written Materials To Be Used with Primary Teachers	1.00
b.	Activity Cards	1.00
c.	Shoebox Materials	
	(1) Tower Puzzle	1.25
	(2) Disc	1.25
	(3) Peg Game	1.25
	(4) Centimeter Blocks	1.25
	(5) Geoboards	1.25

9. McGraw-Hill Book Company
Webster Division
8171 Redwood Highway
Novato, California 94947

a.	Attribute Games and Problems (Teacher's Guide)	1.80
b.	Materials for Attribute Games and Problems	9.60
c.	Tangrams	
	(1) Cards	4.20
	(2) Pieces	2.40
d.	Teacher's Guide for Mirror Cards	1.80
e.	Mirror Cards	10.80

10. McGraw-Hill Book Company
Manchester Road
Manchester, Missouri 63011

a.	Teacher's Guide for Primary Balancing--The Balance Book	2.50
b.	Teacher's Guide for Balancing	3.00
c.	6-Student Kit for Balancing	31.50

11. Cuisenaire Company of America
9 Elm Avenue
Mount Vernon, New York 10550

a.	Mathematical Awareness - Part 1	$ 1.00
b.	Mathematical Awareness - Part 2	1.00
c.	Basic Classroom Kit of Cuisenaire Rods	57.50

12. Vroman's
367 South Pasadena Avenue
Pasadena, California 91105

a.	Probability for Primary Grades - Student	.50
b.	Probability for Primary Grades - Teacher	2.00
c.	Probability for Intermediate Grades - Student	1.00
d.	Probability for Intermediate Grades - Teacher	2.00
e.	Spinners (20 per set)	7.00

13. Encyclopedia Britannica Press
1111 West 40th Street
Chicago, Illinois 60609

a.	Math Workshop - Level A	4.80
b.	Math Workshop - Level B	4.80
c.	Games and Enrichment Activities	?

14. Wirtz-Botel Associates, Inc.
P. O. Box 6211
Carmel, California 93921

a.	Developing Insights into Elementary Mathematics - Operations on Whole Numbers - Student	7.50
b.	Developing Insights into Elementary Mathematics - Operations on Whole Numbers - Teacher	

15. Walker Educational Book Company
720 Fifth Avenue
New York, New York 10019

a.	Inquiry in Mathematics via the Geoboard	2.50
b.	Geoboards (30 per set)	45.00
c.	Geoboard Cards	6.95

16. Math Media Division
H and M Associates
P. O. Box 1107
Danbury, Connecticut 06810

a.	Using the 'Invicta' Plastic Mathematics Balance	.90	
b.	Primary Shapes	8.65	
c.	Trundle Wheel	6.90	
d.	Simple Scale	7.20	
e.	Caliper	7.00	
f.	Tangrams (Invicta)	7.50	
g.	Weight, Area, Volume Set	6.05	
h.	Basic Shapes Set	5.60	
i.	Primary Ruler	2.40	doz.
j.	Mathematics Using String	1.00	

17. Selective Educational Equipment, Inc.
3 Bridge Street
Newton, Massachusetts 02195

a.	Invicta Math Balance	5.50	

18. St. Regis Paper Company
Nifty Division
P. O. Box 588
Houston, Texas

a.	Math Bingo	4.50	
b.	Graph Paper (1" - 11" x 15")	.59	
c.	Graph Paper ($\frac{1}{2}$" - 11" x 15")	.59	
d.	Graph Paper (1" - 22" x 30")	1.95	
e.	Graph Paper ($\frac{1}{2}$" - 22" x 30")	1.95	

19. Lakeshore Equipment Company
Curriculum Materials Center
P. O. Box 2838
Oakland, California 94618

a.	Cubical Counting Blocks	4.00	
b.	Parquetry Design Blocks	2.00	
c.	Meter Sticks	.50	
d.	Chalkboard Protractor	3.00	

20. Hercules Equipment and Rubber Company, Inc.
435 Brannan Street
San Francisco, California 94107

a.	Rubber bands (different sizes and colors)	1.93	lb.

MANIPULATIVE MATHEMATICS LABORATORY MATERIALS

Calculators	2
Lucas Materials	2
Cubical Counting Blocks	2
Parquetry Design Blocks	2
Modeling Clay	1
Crayons	3
Scissors	2 doz.
Pipe Cleaners	2
Glue	5
Meter Sticks	3
Chalkboard Protractor	1
Tower Puzzles	5
Disc	5
Peg Game	5
Centimeter Blocks	5
Geoboards	5
Balance	3
Mirror Cards	2
Graph Paper (1" - 11 x 15)	2 pads
" " (1/2" - 11 x 15)	2 pads
" " (1" - 22 x 30)	2 pads
" " (1/2" - 22 x 30)	2 pads

Trundle Wheel	2
Simple Scale	1
Caliper	1
Tangrams	25 (1/staff)
Weight, Area, Volume	2
Basic Shapes	1
Primary Ruler	12

MOTION PICTURES

Film	Source
Piaget Classification Piaget Conservation	Davidson Films 1757 Union Street San Francisco, California 94123
Wirtz	
No. 1 - How to Teach More Elementary Mathematics, Discovery No. 2 - Numbers Have Many Names No. 3 - Cross Number Puzzles No. 4 - Guess My Rule No. 5 - Problem Solving No. 6 - Tests	Encyclopedia Britannica Films, Inc. 5625 Hollywood Boulevard Hollywood, California 90028
Madison Project	
Addition and Multiplication Using Plastic Washers Guessing Functions Introduction to Geometry via Nail Boards Week of Mathematical Exploration, Monday through Friday (5 reels) Banneker Postman Stories In-Service Films, Nos. 1-10 (10 reels)	The Madison Project Webster College 8356 Big Bend Boulevard St. Louis, Missouri 63119
Nuffield	
Math's Alive I Do, And I Understand	Nuffield Foundation (England) Radim Films 220 West 42nd Street New York, New York 10036